

Lyme Disease



a public information
guide from the

**Centers for Disease Control
and Prevention**

**National Center for Infectious Diseases
Division of Vector-Borne Infectious Diseases**



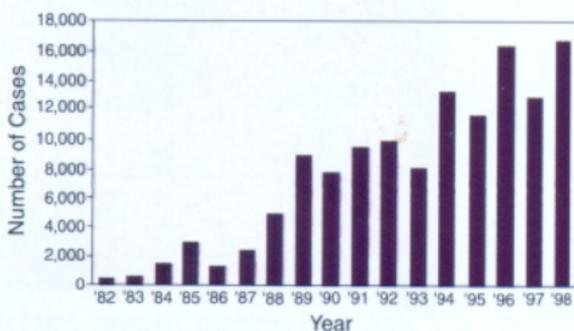
CDC
CENTERS FOR DISEASE CONTROL
AND PREVENTION

DEPARTMENT OF HEALTH & HUMAN SERVICES

LYME DISEASE

Lyme disease was first recognized in the United States in 1975, after an unusual outbreak of arthritis near Lyme, Connecticut.

Since then, reports of Lyme disease have increased dramatically, and the disease has become an important public health problem in some areas of the United States.



Lyme disease is an infection caused by the corkscrew-shaped bacterium *Borrelia burgdorferi*, a member of the family of spirochetes.



How ticks spread the disease

The bite of infected ticks spreads the bacterium that causes Lyme disease. The black-legged (or deer) tick, *Ixodes scapularis*, which normally feeds on the white-footed mouse, the white-tailed deer, other mammals, and birds, transmits Lyme disease bacteria to humans in the northeastern and north-central United States. (In these regions, this tick is also responsible for spreading babesiosis, a disease caused by a parasite similar to the microbe that causes malaria, and human ehrlichiosis, a sometimes severe bacterial disease with fever and chills.) On the Pacific Coast, the bacteria that cause Lyme disease are transmitted to humans by the western black-legged tick, *Ixodes pacificus*.

Ticks in the young stage (nymph) are the main source for transmitting Lyme disease bacteria to humans. Since they are tiny (less than 2 mm) and rarely noticed, nymphs have the necessary time to feed and transmit the bacteria, typically after feeding for 2 or more days. Also, nymphal ticks feed during the spring and summer months when people spend most time outdoors.

photo by M. Fergione



Ticks can attach to any part of the human body but are often found in hard-to-see and hairy areas such as the groin, armpits, and scalp. In most cases, the tick must be attached for 48 hours or more before the bacteria can be transmitted. Shown is an engorged *Ixodes* nymph.

Adult ticks can also transmit Lyme disease bacteria. Because adult ticks are larger and more noticeable, they are more likely to be removed from a person's body within a few hours and therefore are less likely to have had enough time to transmit the bacteria. Moreover, adult *Ixodes* ticks are most active during the cooler months of the year when people spend less time outdoors and wear more clothing which provides added protection.

Ixodes ticks are much smaller than the common dog and cattle ticks. In their larval and nymphal stages, they are no bigger than a pinhead. Adult *Ixodes* ticks are larger, about the size of a small apple seed.

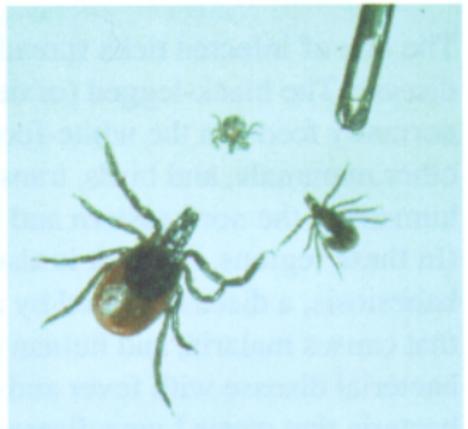


photo by R. Johnson

Ixodes ticks search for host animals from the leaf litter of the forest floor (nymphs) or from the tips of grasses and shrubs (adults) and crawl on to animals or persons. Ticks do not fly or jump. Ticks found on the scalp usually have crawled there from lower parts of the body. Ticks feed on blood by inserting their mouth parts (not their whole bodies) into the skin of a person or animal. *Ixodes* ticks are slow feeders: a complete blood meal can take several days. As they feed, their bodies slowly enlarge.

Although, in theory, Lyme disease could spread through blood transfusions or other contact with infected blood or urine, no such transmission has been documented. There is no evidence that a person can get Lyme disease from the air, food, or water; from sexual contact; or directly from wild or domestic animals. No convincing evidence exists that Lyme disease bacteria are transmitted by insects such as mosquitoes, flies, or fleas.

Campers, hikers, outdoor workers, and others may be exposed to infected ticks when frequenting wooded, brushy, and grassy places. People living in houses built in wooded areas where infected ticks are common may also be exposed to the bacteria that cause Lyme disease. The risk of exposure to ticks is greatest in the woods and in the edge area between lawns and woods, but ticks can also be carried by animals into lawns and gardens and into houses by pets.

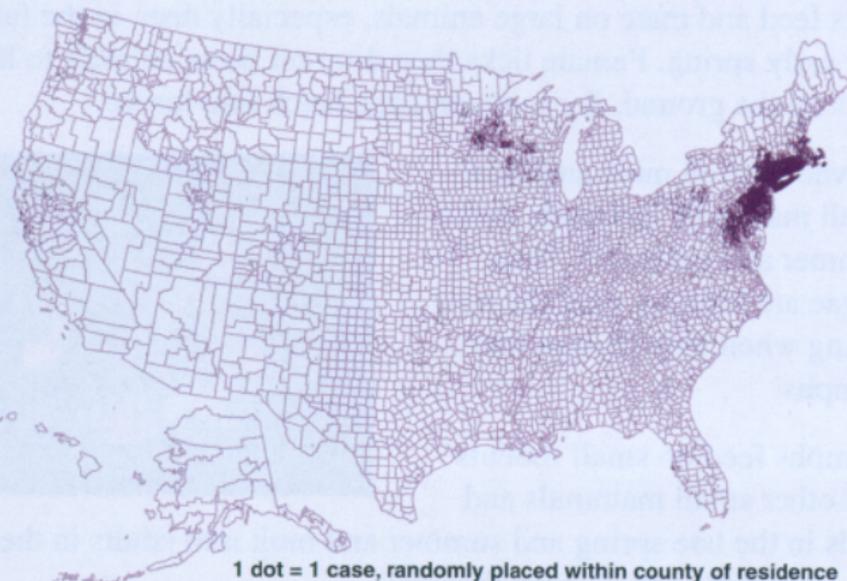
Geographic distribution

Lyme disease is distributed over a wide geographic area in northern temperate regions of the world. In the United States, most infections occur in the

- Northeast, from Maryland to Massachusetts
- North-central states, mostly in Wisconsin and Minnesota
- West Coast, particularly northern California

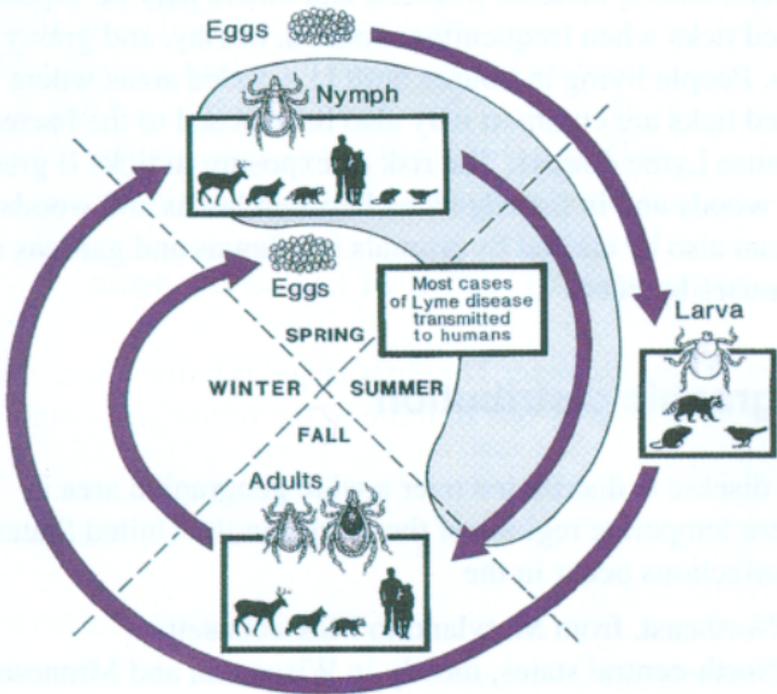
For Lyme disease to exist in an area, three elements must be present in the natural environment: 1) animals that carry Lyme disease bacteria, 2) ticks that can transmit the bacteria, and

Distribution of Lyme Disease Cases Reported to CDC, 1998



3) mammals (such as mice and deer) that can provide food for the ticks in their various life stages. Ticks that transmit Lyme disease bacteria can be found in temperate regions that have a constant high relative humidity at ground level.

Life cycle of Lyme disease ticks



Knowing the complex life cycle of the ticks that transmit Lyme disease bacteria can help in understanding the risk of getting the disease and how to prevent it.

The complete life cycle of these ticks requires 2 years. Adult ticks feed and mate on large animals, especially deer, in the fall and early spring. Female ticks then drop off these animals to lay eggs on the ground. By summer, eggs hatch into larvae.

Larvae feed on mice and other small mammals and birds in the summer and early fall. Then larvae are inactive until the next spring when they change into nymphs.

Nymphs feed on small rodents and other small mammals and birds in the late spring and summer and molt into adults in the fall, completing the 2-year life cycle.



Larvae and nymphs typically become infected with Lyme disease bacteria when they feed on infected small animals, particularly the white-footed mouse. The bacteria remain in the tick as it changes from larva to nymph to adult. Infected nymphs and adult ticks then bite and transmit Lyme disease bacteria to other small rodents, other animals, and humans.

Lyme disease in domestic animals

Domestic animals may become infected with Lyme disease bacteria and some of these (dogs, for instance) may develop arthritis. Domestic animals can carry infected ticks into areas where people live. Studies to determine whether pet owners have an increased risk of Lyme disease have been inconclusive.

Symptoms and signs of Lyme disease

Early Lyme Disease: The early stage of Lyme disease is usually marked by one or more of the following symptoms and signs:

- fatigue
- chills and fever
- headache
- muscle and joint pain
- swollen lymph nodes
- a characteristic skin rash, called erythema migrans

Erythema migrans is a red circular patch that appears at the site of the tick bite usually within 3 days to 1 month after the bite of an infected tick. The patch then grows larger. Sometimes many patches appear, in varying in shapes and sizes. Common sites are the thighs, groin, trunk, and armpits. The center of the rash may clear as it enlarges, resulting in a “bull’s-eye” appearance. The



photo by N.Y. Medical College

rash may be warm, but it usually is not painful. Not all rashes that occur at the site of a tick bite are due to Lyme disease, however. An allergic reaction to tick saliva often occurs at the site of a tick bite and may be confused with the “bull’s-eye” rash of Lyme disease. Allergic reactions to tick saliva usually appear within hours to a few days after the tick bite, usually do not expand, and disappear within a few days.

Late Lyme Disease: Some symptoms and signs of Lyme disease may not appear until weeks, months, or years after a tick bite:

- Arthritis is most likely to appear as brief bouts of pain and swelling, usually in one or more large joints, especially the knees.
- Nervous system abnormalities can include numbness, pain, nerve paralysis (often of the facial muscles, usually on one side), and meningitis (fever, stiff neck, and severe headache).
- Rarely, irregularities of the heart rhythm may occur.
- In some persons, the bull’s-eye rash never appears; in some, the first and only sign of Lyme disease is arthritis, and in others, nervous system problems are the only evidence of Lyme disease.

Lyme disease and pregnancy

Rarely, Lyme disease acquired during pregnancy may lead to infection of the placenta and possibly to stillbirth. However, studies of women infected during pregnancy have found no adverse effects on the fetus when the mother received appropriate antibiotic treatment for her Lyme disease.

Diagnosis

Many of the symptoms of Lyme disease are similar to those of other diseases. The fever, muscle aches, and fatigue of Lyme disease can be mistaken for viral infections, such as influenza or infectious mononucleosis. Joint pain can be mistaken for other types of arthritis, such as rheumatoid arthritis, and neurologic signs can mimic those caused by other conditions, such as multiple sclerosis. On the other hand, other infections, arthritis, or neurologic diseases can be misdiagnosed as Lyme disease.

Diagnosis of Lyme disease should take into account the following factors:

- Patient's history of possible exposure to ticks in areas where Lyme disease is known to occur.
- Symptoms and signs of the illness.
- The results of blood tests used to detect whether the patient has antibodies to the Lyme disease bacterium (*Borrelia burgdorferi*).

Laboratory tests for Lyme disease must be interpreted in relation to the patient's clinical assessment. Both false-positive (the test results read positive, but the patient is not infected with Lyme disease-causing bacteria) and false-negative test results (the results read negative, but the patient is infected with Lyme disease-causing bacteria) may occur. In 1995, recommendations were made to standardize testing for Lyme disease. Two tests that measure the body's production of antibodies to the Lyme disease bacterium are recommended: (1) an enzyme-linked immunosorbent assay (ELISA) or indirect immunofluorescence assay (IFA), followed by (2) a Western immunoblot of samples that tested positive or equivocal by ELISA or IFA. These tests do not detect an infection until the body begins to produce measurable levels of antibodies to the Lyme disease bacterium, usually 2-4 weeks after the bite of an infected tick.

Treatment and prognosis

Lyme disease can be treated effectively with antibiotics. Several antibiotics are effective and are usually given by mouth but may be given intravenously in more severe cases. Patients treated with antibiotics in the early stages of the infection usually recover rapidly and completely. Most patients who are treated in later stages of the disease also respond well to antibiotics. A few patients who are treated for Lyme disease may have persistent or recurrent symptoms, and may require additional antibiotic treatment. Varying degrees of permanent damage to joints or the nervous system can develop in patients with late Lyme disease. Typically these are patients in whom Lyme disease was unrecognized in the early stages, or for whom the initial treatment was unsuccessful. Lyme disease is rarely, if ever, fatal.

Prevention

Tick Control: Removing leaf litter and clearing tall grass and brush around houses and at the edges of lawns may reduce the numbers of ticks that transmit Lyme disease. This is particularly important in the eastern United States, where most transmission of Lyme disease takes place near the home.

Applying acaricides (chemicals that kill ticks) to gardens, lawns, and the edge of woodlands near homes reduces the numbers of ticks in yards. Pesticide application to residential properties should



be supervised by a licensed professional pest control expert.

A relationship appears to exist between the abundance of deer and the abundance of *Ixodes* ticks in the eastern United States.

Reducing and managing deer populations in geographic areas where Lyme disease occurs can reduce tick abundance. Removing plants that attract deer and constructing physical barriers may help discourage tick-infested deer from coming near homes.

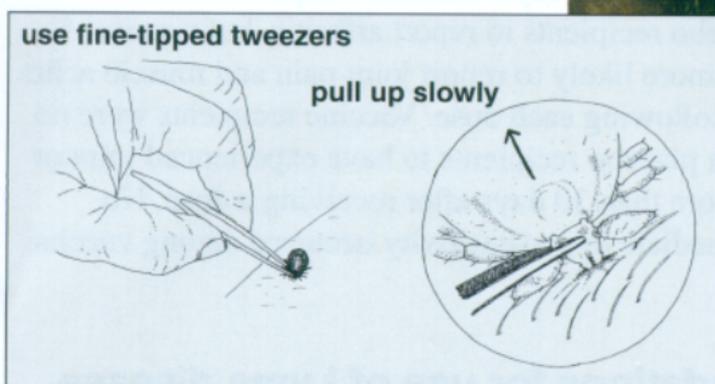
Personal protection from tick bites

You can decrease the chances of being bitten by a tick with a few precautions.

- Avoid tick-infested areas, especially in May, June, and July (many local health departments and park or extension services have information on the local distribution of ticks).
- Wear light-colored clothing so that you can spot ticks more easily.
- Tuck pant legs into socks or boots and shirt into pants to keep ticks on the outside of clothing.
- Tape the area where pants and socks meet so that ticks cannot crawl under clothing.
- Wear a long-sleeved shirt for added protection.
- Spray insect repellent containing a 20-30% concentration of DEET on clothes and on exposed skin other than the face, or treat clothes (especially pants, socks, and shoes) with permethrin, which kills ticks on contact. Follow the manufacturer's instructions when applying repellents.

- Walk in the center of trails to avoid contact with overgrown grass and brush at trail edges.

After being outdoors, wash and dry clothing at a high temperature; inspect body surfaces carefully, and remove attached ticks with tweezers. Grasp the tick as close to the skin surface as possible and pull straight back with a slow steady force. Avoid crushing the tick's body.



drawings by K. Wolff

Preventive Antibiotic Treatment: Giving antibiotics to prevent Lyme disease after a known tick bite is not routinely recommended. Physicians must determine whether the advantages of using antibiotics outweigh the disadvantages in any particular instance. If a patient has been bitten by a tick, the physician should alert the patient to the symptoms of early Lyme disease (and other tick-borne illnesses) and advise the patient to return for reevaluation if symptoms occur.

Lyme disease vaccine

In December 1998, the U.S. Food and Drug Administration (FDA) approved a new vaccine against Lyme disease (LYMERix, marketed by SmithKline Beecham Pharmaceuticals). The vaccine acts by causing the vaccinated person to produce antibodies to the bacteria *B. burgdorferi*, which causes Lyme disease. These antibodies kill Lyme disease bacteria in the tick's gut while it is feeding on the vaccinated person. Three doses are required for optimal protection; the initial dose is followed by a second dose 1 month later and a third dose 12 months after the first. Vaccine

administration should be timed so that the second dose of the vaccine (in year 1), and the third dose (in year 2) are given several weeks before the beginning of the peak tick season, which usually begins in April.

Clinical studies¹ have shown that about 50% of persons were protected against definite Lyme disease after receiving two doses of the vaccine. After receiving three doses, about 80% of persons were protected. About 24% of vaccinated persons reported soreness at the injection site (upper arm). Muscle aches, influenzalike illness, fever, and chills were significantly more common among vaccine recipients than among those who received a placebo, but these symptoms were usually not severe and resolved within a few days. Vaccine recipients were no more likely than placebo recipients to report arthritis, but vaccine recipients were more likely to report joint pain and muscle aches within 30 days following each dose. Vaccine recipients were no more likely than placebo recipients to have experienced joint or muscle aches more than 30 days after receiving a dose. No episodes of immediate hypersensitivity occurred among vaccine recipients.

Recommendations for use of Lyme disease vaccine

Lyme disease vaccine does not protect all recipients against infection with *B. burgdorferi* and offers no protection against other tick-borne diseases. Vaccinated individuals should continue to practice personal protective measures against ticks and should seek early diagnosis and treatment of suspected tick-borne infections. Since Lyme disease is not transmitted from one person to another, use of the vaccine will not reduce risk among unvaccinated individuals. Decisions regarding the use of vaccine should be based on individual assessment of the risk of exposure to infected ticks and on careful consideration of the relative risks and benefits of vaccination compared to other protective measures, including early diagnosis and treatment of Lyme disease. In the United States, risk of Lyme disease is linked with particular geographic locations (see map). Detailed information on the distribution of Lyme disease risk within specific areas is best obtained from state and local public health authorities.

¹Steere AC, Sikand VK, Meurice F, et al. Vaccination against Lyme disease with recombinant *Borrelia burgdorferi* outer-surface lipoprotein A with adjuvant. N Engl J Med 1998;339:209-16.

The Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices has produced recommendations for use of LYMERix for the prevention of Lyme disease (see summary table, p. 12). The complete recommendations were published in the *Morbidity and Mortality Weekly Report*, Recommendations and Reports series, June 4, 1999;48(RR07):1-17.

Lyme disease research

Research continues to address the following concerns:

- Where ticks are most likely to be and how best to protect against them.
- Which chemicals and other strategies are best for controlling ticks in each kind of habitat.
- Ways of making diagnostic tests more accurate.
- How to improve antibiotic treatment.
- How Lyme disease bacteria cause chronic disease of the joints and nervous system and how to prevent these complications.

For more information about Lyme disease,

Write: Division of Vector-Borne Infectious Diseases
National Center for Infectious Diseases
Centers for Disease Control and Prevention
P.O. Box 2087
Fort Collins, CO 80522-2087

Call: 970.221.6400

Fax: 970.221.6476

E-mail: dvbid@cdc.gov

Web site: <http://www.cdc.gov/ncidod/dvbid/dvbid.htm>

CDC Automated Voice & Fax Information System: (toll free)
888.232.3228

Summary of CDC Advisory Committee on Immunization Practices (ACIP) Recommendations Regarding LYMERix Vaccine

Persons who live, work, or participate in recreational activities in areas of high or moderate risk

Persons aged 15–70 years whose exposure to tick-infested habitats is frequent or prolonged Should be considered

Persons aged 15–70 years who have some exposure to tick-infested habitat but whose exposure is neither frequent nor prolonged May be considered

Persons whose exposure to tick-infested habitat is minimal or nonexistent Not recommended

Persons who live, work, or participate in recreational activities in areas of low or no risk Not recommended

Travelers to areas of high or moderate risk

Travelers aged 15–70 whose exposure to tick-infested habitat is frequent or prolonged Should be considered

Children aged < 15 years **Not recommended***

Pregnant women

Health-care providers are encouraged to register vaccinations of pregnant women by calling SmithKline Beecham toll free at 1.800.366.8900, ext. 5231 Not recommended

Persons with immunodeficiency No available data

Persons with musculoskeletal disease Limited data available

Persons with previous history of Lyme disease

Persons aged 15–70 years with previous uncomplicated Lyme disease who are at continued high risk Should be considered

Persons with treatment-resistant Lyme arthritis Not recommended

Persons with chronic joint or neurologic illness related to Lyme disease and persons with second- or third-degree atrioventricular block No available data

Other recommendations

Vaccine schedule

- Three doses administered by intramuscular injection
- Initial dose, followed by a second dose 1 month later, followed by a third dose 12 months after the first dose
- Second dose (year 1) and third dose (year 2) administered several weeks before the beginning of the disease-transmission season (usually April)

Boosters

Existing data suggest boosters might be needed, but additional data are required to make recommendations regarding booster schedules.

Simultaneous administration with other vaccines

If simultaneous administration is necessary, use separate syringes and separate injection sites.

*Clinical trials in children are in progress.

For local information about Lyme disease

Department of Health & Human Services
Centers for Disease Control and Prevention (CDC)
Division of Vector-Borne Infectious Diseases
P.O. Box 2087
Fort Collins, CO 80522-2087

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